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Distalising maxillary molars – how do you do it?

Abstract

Maxillary molar distalisation has been used in orthodontics for over 100 years. This technique has been used to increase space in the maxillary arch for relief of crowding; correction of a Class II molar relationship and reduction of an increased overjet. A plethora of appliances have been developed over the years with each having advantages and disadvantages. This article details the indications and contra-indications for maxillary molar distalisation and details the various appliances that are available to clinicians, presenting the available evidence supporting the use of these various appliances.

Clinical relevance

Clinicians should be familiar with the clinical indications for maxillary molar distalisation, the potential unwanted effects and how these can be minimised. Clinicians should also appreciate how molar distalisation can be incorporated with other aspects of orthodontic care.

Objective

After reading this paper, the primary care dentist and specialist orthodontist will have an in-depth knowledge of the methods for distalising maxillary molars as part of orthodontic care.

Introduction

Angle used headgear appliances to apply traction to retract the maxillary molars in cases with Class II division I malocclusion.[1] Molar distalisation is the term that is now used for lengthening the dental arch by posterior movement of the buccal segment teeth in order to provide space in the maxillary arch. [2] Distal movement of the maxillary molars is mainly used to correct a class II molar relationship,[3,4] to reduce a mild-moderately increased overjet [5] or for treatment of midline deviation problems.[6] As an interceptive measure, maxillary molar distalisation can also provide space for spontaneous eruption of ectopic canines. This has been shown to have a success rate of 80% compared to 50% in a control group.[7] In addition; molar distalisation can be used to regain lost space caused by mesial migration of molars in premolar crowding cases and to upright maxillary first permanent molars when they are impacted against maxillary deciduous second molars.[8,9]

Limitations and contraindications

The indications for, and contraindications of, maxillary molar distalisation are summarised in Table 1. Most distalisation techniques result in loss of anchorage in the form of incisor proclination and are therefore contraindicated where the incisors are already proclined, where the overjet is increased or for patients with a protrusive profile. Molar distalisation should be avoided in cases with thin labial bone and gingival problems due to the risk of gingival recession and bone dehiscence associated with any resultant incisor proclination.[3,10-12] Additionally, distalisation of the maxillary molars is not advised in patients with a high Frankfort-mandibular plane angle or an anterior open bite. This is because the majority of molar distalisation methods are extrusive in nature, resulting in a wedging effect that may open the occlusion.[11,13,14] Buccally flared maxillary molars are a further contraindication to molar distalisation since a force applied buccally to the centre of rotation may cause further buccal tipping. This is due to the cortical bone of these teeth being less

resistant than palatal bone which favours buccal tipping. This in turn, may compromise the overbite and cause a backwards rotation of the mandible.[15]

Maxillary molar distalisation is not a solution to significant crowding (more than 6mm) since the actual maximum amount of space gained is somewhat disappointing at between 2mm-2.5mm.[16] Maxillary molar distalisation should be used with caution in cases with posterior crossbites since the distalised molars tend to occlude more palatally to the wider part of the opposing mandibular dental arch. This can be counteracted by incorporating a midpalatal screw in the distalisation appliance (see Pendulum appliance and nudger appliance sections below), activated twice per week to create expansion in the molar region.[17] Moreover, as the maxillary molar is tipped distally, it has a tendency to rotate around the palatal roots depending on the site of applied force, buccal or palatal~~disto-palatally~~. ~~This is thought to be due to the nature of the buccal cortical bone surrounding these teeth; and~~If the distalisation technique include a palatally applied force, as in Pendulum appliance, placing approximately 30 degrees of rotation in the terminal legs of the Pendulum/Pend-X springs can compensate for this.[18] One important fact to consider is the depth of the palatal vault as intraoral molar distalisation appliances that rely on palatal bone anchorage are not effective in cases with a shallow palatal vault.[19]

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Molar distalisation techniques

Contemporary maxillary molar distalisation techniques are shown in Figure 1.

Mini-Distalisation techniques

These include the use of brass wire ligatures, elastomeric separators and steel spring clip separators which all act by disimpacting molars that are mesially impacted against an adjacent tooth. Mini-distalising has been shown to assist partially erupted, tipped and impacted molars to erupt normally.[20] Other methods include the Halterman appliance (Figure 2)[21] and the Humphrey appliance, the latter consisting of a Nance appliance

attached to the deciduous molars and a welded 'S' shaped wire spring bonded to the mesial ridge of the ectopic molar using composite (Figure 3).

Macro-Distalisation techniques

Macro-distalisation methods have been investigated in a number of studies (Table 2). In general, the macro-distalisation techniques can be subdivided into:

1. Compliance Appliances

One of the most well-known methods of maxillary molar distalisation is headgear. It is attached via a facebow to molar bands on the maxillary first permanent molars in a high or low pull direction depending on the overbite (figure 4). The force level used is 300-350gm per side and if the appliance is worn 14 hours/day around 2-3mm of molar distalisation can be achieved.[16]

Removable functional appliances can be considered as a compliance-dependent maxillary molar distalisation technique. One of the effects of functional appliances is correction of the molar relationship. This is achieved by a combination of skeletal changes (19% in the maxillary base and 22% in the mandibular base) as well as dentoalveolar changes (26% in the maxillary dentition and 33% in the mandibular dentition).[22]

A removable appliance (~~nudger~~Nudger appliance) can be used for maxillary molar distalisation. Either palatal finger springs (0.6mm wire) or screws can be used as the active component (Figure 5). A Southend clasp on the incisors and Adams clasps for the molars ~~(when a screw is used)~~ and premolars (except the tooth to be moved) aid with appliance fixation. An anterior or posterior biteplate may be required to disengage the occlusion and permit uprighting of the tilted permanent molar (as well as reduction of an increased overbite). Anchorage loss normally manifests as an increase in the overjet.[23]

A ~~nudger~~Nudger appliance and headgear in combination can be used for maxillary molar distalisation to achieve bodily tooth movement. The combination system consists of an

upper removable appliance (URA) with palatal finger springs (activation of 2-3mm) that act to tip the crown of the molar distally. High-pull headgear worn at night, directed above the centre of rotation of the molar, acts to distalise the root and hold the crown movement achieved during the day-time wear of the URA.[24] In addition, the headgear provides a method of reinforcing the anchorage during subsequent retraction of the anterior teeth. Ferro et al [25] showed an average of 3.6mm of molar distal movement and 0.7mm of anchorage loss when a ~~nudger~~Nudger appliance was used in conjunction with cervical headgear.

Additionally, a removable appliance can also be used for en masse maxillary molar distalisation. The standard design of an en masse removable appliance described by McCallin consisted of Adams clasps for the maxillary first permanent molars and first premolars, L-shaped rests over the first molars and headgear tubes soldered to the bridges of the Adams clasps on the first permanent molars. A coffin spring to provide expansion is embedded in the heat-cured acrylic baseplate.[26] Other modifications of the en masse appliance as described by Orton include replacement of the coffin spring by a midline expansion screw to provide symmetrical bilateral expansion, double clasps for the upper first permanent molars and second premolars, T-shaped occlusal rests and headgear tubes soldered to the molar portion of the double clasps. Headgear delivering 300-350gm per side should be used for 14 hours per day. Extraction of the upper second permanent molars may be required. This method has been claimed to achieve 6mm distal movement of the molars.[27]

Another compliance method for maxillary molar distalisation is the Molar Distalising Bow. It consists of two components. First, a 0.8–1.5 mm thick thermoplastic splint is placed over the maxillary model covering the dentition except the teeth to be moved and is extended into the buccal sulcus for better support and retention. A distalising bow with open coil springs to apply a force to the permanent molars is then fitted into the anterior slot that is embedded in the splint.[28]

Class II elastics with sliding jigs to distalise the buccal segments are the last in the list of the most commonly used compliance-based maxillary molar distalisation techniques (Figure 6). Unlike other compliance-dependent methods, elastics produce a pulling force rather than a pushing force. Class II elastics are a mainstay of the original Tweed technique in which the pulling forces from the Class II elastics are transmitted to a pushing force via the sliding jigs to distalise the maxillary molars. A force level of 300-350 gm per side is required. In addition the class II elastics help in the correction of the class II malocclusion by clockwise rotation of the occlusal plane. It is possible to compensate for this in a growing patient but sliding jigs and Class II elastics are not recommended for more than a period of 6 months in adult patients due to unwanted occlusal effects.[28,29]

2. Non-compliance Class II correctors

These have been subdivided by McSherry[30] into inter-maxillary and intra-maxillary appliances:

a. *Inter-maxillary appliances*

These can be sub classified into:

I. *Appliances producing pulling forces*

The Severable Adjustable Intermaxillary Force (SAIF) springs (www.truforce.com) were developed by Armstrong in 1957.[31] They consist of long nickel-titanium closed coil springs that are used to apply Class II inter-maxillary traction when fully bonded fixed appliances are in place. The springs are available in two lengths; 7mm and 10mm.[30] No long-term studies have been published on the use of SAIF springs and they are not used widely because of difficulties encountered in appliance management, including breakage, oral hygiene difficulties and problems with patient comfort.

II. Appliances producing pushing forces

These include appliances that deliver a 'pushing' force vector, forcing the attachment points of the appliance away from one another.[31] In this category are the Class II bite correctors which can be considered as a method of molar distalisation since there is thought to be a 'headgear effect' with these appliances.[32] Class II bite correctors include:

1. The Herbst appliance (www.americanortho.com): a fixed functional appliance popularised by Pancherz.[33] It consists of a bilateral telescopic mechanism that protrudes the mandible with compensatory maxillary molar distalisation. The sagittal correction of the molar relationship results from a combination of skeletal changes (43%) and dentoalveolar changes (57%).[32] Its action is similar to that of the Forsus springs (3M, Monrovia, California, USA) and AdvanSync bite correctors (Ormco, California, USA) that are used in conjunction with a trans-palatal arch (figure ~~6A~~ 7A and B).
2. The Jasper Jumper (www.americanortho.com) consists of two vinyl coated auxiliary springs attached to the maxillary first permanent molars and to the mandibular archwire anteriorly, with the springs resting in the buccal sulcus. The springs hold the mandible in a protruded position. The majority of the action is reported to be dental, rather than skeletal change.[34]
3. The adjustable bite corrector is similar to the Herbst appliance and to the Jasper Jumper. The advantages are the adjustable length, stretchable springs, and easy adjustment of the attachment parts.[35] No long-term studies have been published on this appliance to date.[30]
4. The Mandibular Anterior Repositioning Appliance (MARA)[31] (www.ortho-concept.com/mara) consists of heavy ''elbow-shaped'' wires attached to tubes on the maxillary first permanent molar bands or stainless steel crowns. A mandibular first permanent molar crown has an arm projection which engages the elbow of the maxillary molar. The appliance is adjusted so that when the mandible elevates, the elbow wire guides the lower first permanent molars and repositions the mandible forwards into a Class I relationship. The results of treatment with the MARA are very similar to those produced by the Herbst appliance but with less

'headgear' effect on the maxilla and less mandibular incisor proclination than with the Herbst appliance[36] (Figure 8).

b. Intra-maxillary appliances

1. Lip bumper: this consists of a thick round stainless steel wire that fits into the headgear tube of the molar band and is held away from the labial surface of the incisor by loops mesial to the entrance of the molar tubes. The anterior part of the wire is embedded in an acrylic shield which actively displaces the lip forward. The reciprocal force of the displaced lip is transferred to the molars via the heavy wire and results in molar uprighting and distalisation. Changes in the soft tissue equilibrium due to the lip bumper can lead to proclination of the incisors as well as an increase in intercanine width.[24,37]
2. Pendulum Appliance: this consists of a large Nance button supported and retained by premolar bands and 0.032-inch titanium-molybdenum alloy (TMA) springs inserted into lingual sheaths on the palatal surface of the bands to distalise the maxillary molars. For additional retention, bonded occlusal rests on the primary molars or second premolars can be included. If a midline screw is added to counteract a potential crossbite or to correct an actual crossbite, then the appliance is called a Pend-X appliance (Figure 9).[18] The anchorage loss due to incisor proclination will occur in a ratio of approximately 1/3-1/2 of the amount of distalisation of the molar.[38,39] However, the presence of the maxillary second molars change the ratio, so if the appliance is used after eruption of the second molars, the ratio will be 2/3.[18] This is a similar to the result found by Karlsson,[40] who showed that the most opportune time to distalise maxillary first permanent molars is before eruption of the second molars. The Pendulum appliance is better tolerated by patients and results in a shorter duration of treatment in comparison to HG.[41]
3. Jones Jig and Lokar Distalizing Appliance: the Jones Jig (www.americanortho.com) uses open-coil nickel-titanium springs attached to the maxillary first permanent molars, and a Nance button attached to the maxillary first or second premolars or the primary molars.[42] A similar mechanism, called the Lokar Distalizing Appliance (www.ormco.com) has reported

advantages of ease of insertion and ligation.[30] interestingly, Paul and O'Brien[43] found no difference between the effectiveness of the Nudger URA and the Jones jig for maxillary molar distalisation.

4. Distal Jet (www.americanortho.com): This uses bilateral tubes of 0.036-inch internal diameter attached to an acrylic Nance button with a coil, and screw clamps slid over the tube. The wire from the acrylic ends in a bayonet bend and inserts into a palatal sheath on the maxillary molar band. The Nance button is also attached to a premolar band via a connecting wire. It is claimed that this appliance overcomes the disadvantages of other appliances used for distalising maxillary molars by reducing the tendency for the teeth to tip, because the force acts through the centre of resistance of the molar and thus produces true bodily tooth movement.[15] Bondemark compared headgear and the Distal Jet in a randomised controlled trial and found that the Distal Jet was more effective than the headgear in producing distal movement of the maxillary first permanent molars; however the anchorage loss was greater with the Distal Jet[44] (Figure 10).
5. Nance palatal arch and coil springs: several authors have described the use of a modified Nance palatal arch with coils to distalise maxillary molars.[19] One of these studies compared the effect of the modified Nance palatal arch with coils (MNA group) and the repelling rare earth magnet (RRRM group) for molar distalisation. The authors showed that the amount of maxillary molar distalisation was greater in the MNA group than the RRRM group with improved patient perception with the former group.[45]
6. Repelling Magnets: it has been shown that it is possible to achieve distal movement of the molars using repelling magnets with faster results when the second permanent molars are unerupted.[45] However one of the difficulties of using repelling magnets is the force decay over time with the need for frequent reactivation (on a weekly basis) in addition to the difficulty of using them with other metallic appliances such as headgear.[46]
7. Goshgarian appliance: the Goshgarian appliance can be used to distalise the maxillary molars unilaterally or bilaterally to correct a mild class II molar relationship by activating the

V shape bend of the TPA, as described by Rebellato in 1995.[47] In a unilateral maxillary molar distalisation case it is better to reinforce the stable side with headgear, place torque in the archwire to take advantage of cortical anchorage or use temporary anchorage devices.[48-52]

8. Mini Implants: Ismail and Johal (2002)[53] used mini implants for anchorage to allow for distalisation of the maxillary molars. They showed that suitable sites for the implants are the palatal vault and the retromolar region. If extractions of the maxillary second permanent molars are carried out, then 4-5mm of distalisation is achievable.[53] Other uses of the miniscrew implant in the distalisation of the maxillary molars is by supporting anchorage in addition to placing a Distal Jet appliance[54] or bone anchored pendulum anchorage.[14]

Evidence for the effectiveness of molar ~~distalisaton~~distalisation

Both retrospective and prospective studies have shown slightly disappointing findings. Distal movement of the maxillary molars in patients who wore cervical headgear for an 8-month period did not differ from that of an untreated group when they were re-evaluated 7 years later [55]. Benson et al[2] compared headgear and a midpalatal implant in a randomised clinical trial as a method of maxillary molar distalisation in a group of 51 patients. They found that the molar movement was greater in the implant group than in the headgear group and point 'A' in the cephalometric tracings moved in the opposite direction in the headgear group. They concluded that there is no difference between these methods for maximising anchorage.[2]

Systematic reviews have shown similarly modest amounts of maxillary molar distal movement can be achieved. Atherton et al undertook a systematic review to investigate various distalisation methods and detected the amount of maxillary molar distalisation that could be achieved is in the range of 2mm-2.5mm (Table ~~1~~2).[16] Another recent systematic review was undertaken by Bondemark and ~~-~~Karlsson et al.[44~~56~~] They found that intraoral appliances for maxillary molar distalisation are more effective than extraoral appliances.

However, they recorded moderate but acceptable anchorage loss with intraoral appliances causing an increase in the overjet, whereas the extraoral appliances resulted in a decrease in the overjet. Neither appliance had any significant skeletal effects. They concluded that the optimum time to move maxillary first permanent molars distally is before eruption of the second permanent molars. The findings of Bondemark and Karlsson systematic review was almost similar to the finding of the latest Cochrane review with regards to the effectiveness of different distalisation technique. [56]

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Transition from molar distalisation to fixed appliances

The techniques for transition (or retention) following maxillary molar distalisation are similar to that of the transition from functional appliances to fixed appliances. These include:[57,58]

1. Overcorrection: moving the molars into a mild Class III relationship to compensate for any relapse.
2. Quick-Nance: Fabricated from 0.032'' stainless steel that feeds inside the lingual sheath of the molar bands. The palatal button can be adapted and cured using light cure acrylic resin (Triad, www.dentsply.com).
3. Conventional Nance arch or transpalatal arch.
4. Short-term headgear: This also helps distally upright molar roots at a force range of (250-300 grams/side) 12 hours per day.
5. Stops on the archwires can stabilise the maxillary molar position. However, any rebound will be expressed as an increased overjet, so additional anchorage techniques should be used as well.
6. Maxillary utility arch (which acts in a similar way to stops on the arch-wire). This can be used in the mixed dentition and in cases with a Class II division 2 malocclusion where correction of a deep overbite often results in incisor proclination thus reducing the overbite. The utility arch has an advantage if treatment involves the use of class II elastics since this archwire provides a method for elastic attachment.

7. Immediate Class II elastics can be used but one of the drawbacks is the need for a mandibular arch appliance which becomes more complicated to place if the overbite is increased.
8. Lip bumper for the maxillary arch.
9. Hawley-type retainers: these may be utilised when the tissues are overly inflamed for immediate transition to a fixed appliance.
10. Functional appliances such as the Bionator appliance to maintain the distalised maxillary molar position while encouraging forward movement of the mandibular arch. The Herbst appliance can allow concurrent bonding and space closure in the maxillary arch.

The method selected will depend on the ~~individual case~~clinician preference and patient related factors such as cost, compliance and type of malocclusion which~~ with a number of clinical factors being~~ahould be taken into account.

Conclusion

Distal movement of the maxillary molars to produce space for relief of crowding, correction of a Class II molar relationship and reduction of an increased overjet can be undertaken with a range of appliances. Clinicians should be aware that the amount of tooth movement achieved with these appliances is modest.

Captions:

Table 1: Indications and contraindications for maxillary molar distalisation

Table 2: Effectiveness of maxillary molar distalisation with different methods (adapted from Atherton et al [16])

Figure 1: Methods for maxillary molar distalisation

Figure 2: Halterman appliance (consists of a transpalatal arch on molars with an attached distal spring bonded to the first permanent molars)

Figure 3: Humphrey appliance (reproduced from Nagaveni NB, Radhika NB. Interceptive orthodontic correction of ectopically erupting permanent maxillary first molar. A case report. Virt J Orthod 2010; 8: 1-13.)

Figure 4: Extraoral photos of low pull headgear

Figure 5: An upper removable appliance (nudger appliance) with two screws to distalise the upper right buccal segment and to counteract the potential crossbite

Figure 6: Class II Mechanics with sliding jigs used to distalise upper left buccal segment (decompensation of a Class III malocclusion before orthognathic surgery)

Figure 7: (A) Forsus (3M, Monrovia, California, USA) and (B) AdvanSync bite correctors (Ormco, California, USA)

Figure 8: Mandibular Anterior Repositioning Appliance[31]

Figure 9: Pend-X appliance

Figure 10: Distal Jet appliance

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